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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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SALMAN AKRAM

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3303

7590

12/10/2004

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EXAMINER

LEE, EUGENE

ART UNIT

PAPER NUMBER

2815

DATE MAILED: 12/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/388,031

Applicant(s)

AKRAM, SALMAN

Examiner

Eugene Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 November 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28 and 100-129 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 16-28, 101 and 116-129 is/are allowed.
- 6) ☒ Claim(s) 1-15, 100 and 102-115 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11/22/04 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 4, and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. 6,074,943 in view of Lee et al. 6,436,816 B1. Brennan discloses (see, for example, FIG. 3) an interconnect structure (metallization structure) comprising an underlying layer (substrate) 300, a conductive line consisting of an interconnect (single conducting layer) 310, and a thick buffer region (spacers) 320. In column 1, lines 33-39, Brennan discloses that the thick buffer region may be metal. Brennan does not disclose a metal layer defining a pattern on a portion of the substrate upper surface. However, Lee discloses (see, for example, FIG. 2D) an interconnect structure comprising a barrier metal layer (metal layer) 120 and a copper layer 140. The barrier metal layer stabilizes the copper layer on the substrate 10. Therefore, it would

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have been obvious to one of ordinary skill in the art at the time of invention to have a metal layer defining a pattern on a portion of the substrate upper surface in order to stabilize the interconnect on the underlying layer.

Regarding claims 4 and 7, Lee discloses (see, for example, column 12, lines 1-9) that the barrier metal layer comprises TaN or TiN.

4. Claims 2, 3, 100, 102 thru 104, and 107 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 as applied to claims 1, 4 and 7 above, and further in view of Chang et al. 6,281,115 B1. Brennan in view of Lee does not disclose a dielectric layer on the substrate upper surface and underlying the metal layer. However, Chang discloses (see, for example, FIG. 3) a conductive structure comprising interconnect metal structures 3 over an insulator layer 2 and substrate 1. The insulator layer serves as a base upon which the interconnect metal structures are constructed. Therefore it would have been obvious to one of ordinary skill in the art at the time of invention to have a dielectric layer on the substrate upper surface and underlying the metal layer in order to provide a base for the interconnect structure.

Regarding claims 3 and 103, see, for example, column 3, lines 14-19 wherein Chang discloses the insulator layer comprising silicon oxide or BPSG.

5. Claims 5, 6, 10, 11, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 as applied to claims 1, 4, and 7 above, and further in view of Liu et al. 6,277,745 B1. Brennan in view of Lee does not disclose a second

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metal layer disposed between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN. However, Liu discloses (see, for example, FIG. 1D, and column 3, lines 38-42) a bottom barrier layer 4 wherein the layer may comprise materials such as TaN, TiN, Ta, or various single or stacked (second metal layer) combinations. The bottom barrier layer passivates the underside of the copper layer. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have a second metal layer disposed between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN in order to adequately passivate the interconnect from the substrate.

Regarding claims 10, 11, and 15, Brennan in view of Lee does not disclose the metal spacers comprising at least one of Ti, Ta, W, Co, or Mo, or alloys thereof or compounds thereof, including TaN and TiN. However, Liu describes (see, for example, column 4, lines 24-29) an interconnect structure comprising protective spacers wherein the protective spacers may comprise Ta, TaN, TiN, or combinations thereof. Therefore it would have been obvious to one of ordinary skill in the art at the time of invention to have the metal spacers comprising at least one of Ti, Ta, W, Co, or Mo, or alloys thereof or compounds thereof, including TaN and TiN in order to adequately protect the sidewalls of the interconnect structure.

6. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 as applied to claims 1, 4, and 7 above, and further in view of Joshi et al. 6,285,082 B1. Brennan in view of Lee does not disclose the single conducting layer being selected from the group comprising aluminum and copper. However, Joshi discloses (see, for example, column 1, lines 20-25, and column 3, lines 65-67) that

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aluminum and aluminum-copper have low resistivity, superior adhesion, ease of patterning, high purity, and low cost of materials. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have the single conducting layer being selected from the group comprising aluminum and copper in order to have low resistivity, superior adhesion, ease of patterning, high purity, and low cost of materials.

7. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 as applied to claims 1, 4, and 7 above, and further in view of Dawson 6,677,647 B1. Brennan in view of Lee does not disclose a dielectric layer on the single conducting layer and having sidewalls aligned with the sidewalls of the single conducting layer, the metal spacers extending along the sidewalls of the dielectric layer. However, Dawson discloses (see, for example, FIG. 1) an interconnect structure comprising a metal line 108 and anti-reflective coating (dielectric layer) 110. In column 2, lines 3-10, Dawson discloses the anti-reflective coating comprising TiN, and further discloses the anti-reflective coating reducing electromigration and serving as an etch stop layer. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have a dielectric layer on the single conducting layer and having sidewalls aligned with the sidewalls of the single conducting layer, the metal spacers extending along the sidewalls of the dielectric layer in order to reduce electromigration and have an etch stop layer.

8. Claims 13 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 in view of Dawson '647 B1 as applied to claim

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12 above, and further in view of Matsuno 6,046,502. Brennan in view of Lee in view of Dawson does not disclose a low dielectric constant material and a fluorine-doped silicon oxide. However, Matsuno discloses (see, for example, see column 1, lines 20-63) that dielectric films doped with fluorine provide films with low dielectric constants which have excellent burying properties and lowered propagation delay. Therefore it would have been obvious to one of ordinary skill in the art at the time of invention to have a low dielectric constant material and a fluorine-doped silicon oxide in order to have excellent burying properties and lowered propagation delay.

9. Claims 105, 106, 110, 111, and 115 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 in view of Chang et al. '115 B1 as applied to claims 2, 3, 100, 102-104, and 107 above, and further in view of Liu et al. 6,277,745 B1. Brennan in view of Lee in view of Chang does not disclose a second metal layer disposed between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN. However, Liu discloses (see, for example, FIG. 1D, and column 38-42) a bottom barrier layer 4 wherein the layer may comprise materials such as TaN, TiN, Ta, or various single or stacked (second metal layer) combinations. The bottom barrier layer passivates the underside of the copper layer. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have a second metal layer disposed between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN in order to adequately passivate the interconnect from the substrate.

Regarding claims 110, 111, and 115, Brennan in view of Lee in view of Chang does not disclose the metal spacers comprising at least one of Ti, Ta, W, Co, or Mo, or alloys thereof or

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compounds thereof, including TaN and TiN. However, Liu describes (see, for example, column 4, lines 24-29) an interconnect structure comprising protective spacers wherein the protective spacers may comprise Ta, TaN, TiN, or combinations thereof. Therefore it would have been obvious to one of ordinary skill in the art at the time of invention to have the metal spacers comprising at least one of Ti, Ta, W, Co, or Mo, or alloys thereof or compounds thereof, including TaN and TiN in order to adequately protect the sidewalls of the interconnect structure.

10. Claims 108 and 109 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 in view of Chang et al. '115 B1 as applied to claims 2, 3, 100, 102-104, and 107 above, and further in view of Joshi et al. 6,285,082 B1. Brennan in view of Lee in view of Chang does not disclose the single conducting layer being selected from the group comprising aluminum and copper. However, Joshi discloses (see, for example, column 1, lines 20-25, and column 3, lines 65-67) that aluminum and aluminum-copper have low resistivity, superior adhesion, ease of patterning, high purity, and low cost of materials. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have the single conducting layer being selected from the group comprising aluminum and copper in order to have low resistivity, superior adhesion, ease of patterning, high purity, and low cost of materials.

11. Claims 112 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 in view of Chang et al. '115 B1 as applied to claims 2, 3, 100, 102-104, and 107 above, and further in view of Dawson 6,677,647 B1. Brennan in view of Lee

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in view of Chang does not disclose a dielectric layer on the single conducting layer and having sidewalls aligned with the sidewalls of the single conducting layer, the metal spacers extending along the sidewalls of the dielectric layer. However, Dawson discloses (see, for example, FIG. 1) an interconnect structure comprising a metal line 108 and anti-reflective coating (dielectric layer) 110. In column 2, lines 3-10, Dawson discloses the anti-reflective coating comprising TiN, and further discloses the anti-reflective coating reducing electromigration and serving as an etch stop layer. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to have a dielectric layer on the single conducting layer and having sidewalls aligned with the sidewalls of the single conducting layer, the metal spacers extending along the sidewalls of the dielectric layer in order to reduce electromigration and have an etch stop layer.

12. Claims 113, and 114 rejected under 35 U.S.C. 103(a) as being unpatentable over Brennan et al. '943 in view of Lee et al. '816 B1 in view of Chang et al. '115 B1 in view of Dawson '647 B1 as applied to claim 112 above, and further in view of Matsuno 6,046,502. Brennan in view of Lee in view of Chang in view of Dawson does not disclose a low dielectric constant material and a fluorine-doped silicon oxide. However, Matsuno discloses (see, for example, see column 1, lines 20-63) that dielectric films doped with fluorine provide films with low dielectric constants which have excellent burying properties and lowered propagation delay. Therefore it would have been obvious to one of ordinary skill in the art at the time of invention to have a low dielectric constant material and a fluorine-doped silicon oxide in order to have excellent burying properties and lowered propagation delay.

Allowable Subject Matter

13. Claims 16 thru 28, 101, and 116 thru 129 are allowed.

14. The following is a statement of reasons for the indication of allowable subject matter:

The references of record, either singularly or in combination, do not teach or suggest at least “a metallization structure, comprising a substrate having a metal layer extending over the substrate, the metal layer at least underlying a conductive line; a conductive layer of the conductive line in contact with the metal layer and the metal spacer, the metal spacer and the conductive layer substantially filling the aperture, the conductive layer having an upper surface substantially coincident with an upper surface of the dielectric layer” (claims 16-25, and 101).

Regarding claims 26-28, the references of record, either singularly or in combination, do not teach or suggest at least “a metallization structure, comprising a substrate having a metal layer extending over the substrate, the metal layer at least underlying a conductive line; a conductive layer of the conductive line in contact with the metal layer and the metal spacer, the metal spacer and the conductive layer nearly filling the aperture, at least one upper metal layer on the conductive layer, the at least one upper metal layer having an upper surface substantially coincident with an upper surface of the dielectric layer and an uppermost extent of the metal spacer.”

Regarding claims 116-125, and 129, the references of record, either singularly or in combination, do not teach or suggest at least “a structure for transmitting a signal laterally across a substrate, the structure comprising: a substrate having a metal layer of a conductive line; a conductive layer of the conductive line in contact with the metal layer and the metal spacer, the

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conductive layer having an upper surface substantially coincident with an upper surface of the dielectric layer.”

Regarding claims 126-128, the references of record, either singularly or in combination, do not teach or suggest at least “a structure for transmitting a signal laterally across a substrate of a semiconductor device, the structure comprising: a substrate having a metal layer of a conductive line disposed thereon; a conductive layer of the conductive line in contact with the metal layer and the metal spacer, the metal spacer and the conductive layer nearly filling the aperture; and at least one upper metal layer on the conductive layer having an upper surface substantially coincident with an upper surface of the dielectric layer and an uppermost extent of the metal spacer.”

Response to Arguments

15. Applicant's arguments with respect to claims 1-28, and 100-129 have been considered but are moot in view of the new ground(s) of rejection.

INFORMATION ON HOW TO CONTACT THE USPTO

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eugene Lee whose telephone number is 571-272-1733. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 571-272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Eugene Lee
December 8, 2004

A handwritten signature in black ink, appearing to be 'Eugene Lee', written in a cursive style.